

Hot Iron

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Editorial

Welcome to the start of a new **Hot Iron** year! I am very pleased to report that, as in earlier years, there is a loyal group of members who support this journal in addition to those who join from the 'free' membership which I include with the more expensive kits. I do appreciate your support, it makes the effort of scratching the brain well worth while - thank you! That leads to my usual request for material! Contributions from all of you will make it all the more interesting - so please keep them coming. Don't worry about producing tidy copy or drawings - I can handle that without difficulty. Articles, questions, comments etc. are all very welcome. Get your 'pens' out or it will all be my prose!

Our member Andy Howgate, G7WHM, has recently been in contact about the licence conditions and morse tests. He is a very keen constructor (of radio devices as well as having many other interests) and feels very strongly that the morse test requirement as a condition of entry to the HF bands is way out of date! He makes the point that this is a test of morse ability and not much else! Nor is it related to any particular group of bands! Encouraging home radio construction

skills is an essential objective but effectively enticing newcomers to the V/UHF bands means it is almost impossible for them to obtain that real thrill of the first contact with a homebrew rig. It is so much easier to get things to work at HF and it would lead to more Club construction activity. Many other countries have decided to already, or are thinking about, abandoning the morse test as an entry requirement. The UK total of five different licence classes is too complex - I would have just two. Firstly a simple theory cum practical exam, like the Novice one, permitting low power operation by newcomers for a few years min, on some HF and VHF bands for only CW, SSB and FM. The main licence would follow a tougher test demonstrating sufficient technical and operating skills for the full range of bands/services. Use the same call but with different suffices. Any comments?

New Developments

Not a great deal to report thanks to holidays and harvesting! (I have only started this on Aug. 13th because it has started raining!) I shall very soon be sending out press releases on the **Bristol**. A few early models are out and being worked on. My own is now working happily with 10, 15, 20, and 80m normally installed for SSB and CW complete with meter kit and digital readout. See later!

I have been giving some thought to a Direct Digital Synthesis driven VFO or signal generator kit. At present I am undecided as to whether it should be controlled by a dedicated microprocessor or by conventional hard logic. I have no recent experience of micros and am slightly uneasy because it would undoubtedly take me quite a while to become sufficiently proficient - I should love to hear from anybody with suitable skills who is interested in such a project.

Tim Walford G3PCJ Editor

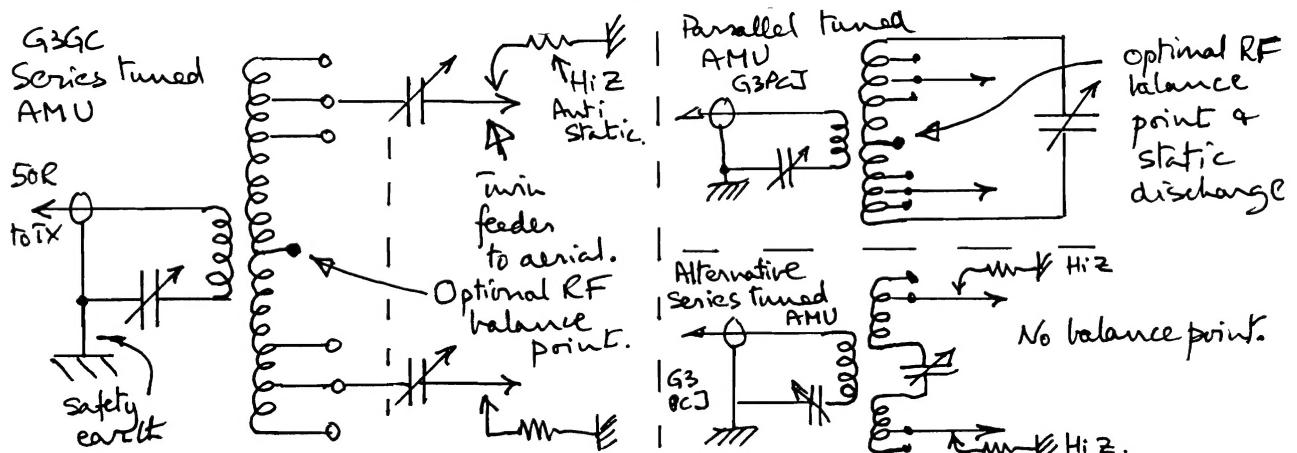
Hot Iron is a quarterly newsletter for radio amateurs interested in building equipment. It is published by Tim Walford G3PCJ for members of the **Construction Club**. Articles on simple theory, construction, testing, updates on kits, questions and suggested topics are always wanted. Please send correspondence and membership inquiries to Upton Bridge Farm, Long Sutton, Langport, Somerset, TA10 9NJ. Tel 01458 241224 or e mail walfor@globalnet.co.uk The Walford Electronics website can be seen at www.users.globalnet.co.uk/~walfor The Copyright of all material published in *Hot Iron* is retained by TRN Walford. ©. Subscriptions are £6 per year for the UK (£8 overseas) from Sept 1st in each year.

Antenna Matching Unit for 40m Doublet - comments by Eric Godfrey G3GC

(As I hoped, Eric has produced some notes on my suggestion for Craig G0HDJ in Hot Iron 28.)

'Firstly, I am unsure what Craig meant by a 40m doublet. A doublet maybe any length but since it is defined as a 40m version, then it is presumably either a half or full wave long. It is also not clear whether the impedance of the twin feeder to be used is nominally high between 300 and 600 Ohms or whether it is low at around 80 Ohms. Both considerations, with feeder length, will make a lot of difference to the impedance which the matching unit will have to transform to the nominal 50 Ohms required for the transmitter.

When I saw the article, I was immediately surprised by the number of turns on the link coupling coil. On reading the text, I gathered you were also surprised at the initial suggestion of 19 turns and that you thought 9 was more appropriate. I have never seen a matching unit with as many link turns before. All the other values including 'safety factors' seem to be what might be expected. It is not uncommon for such AMUs to be capable of parallel or series tuning for low impedance loads but this does require more switching or a split stator capacitor as shown below left.

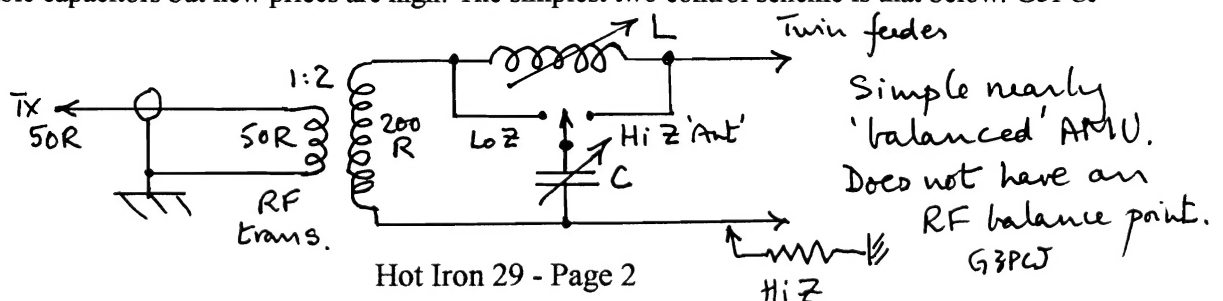


The twin feeder impedance does affect the matching unit's requirements. Consider a resonant half wave doublet, whose centre impedance will be around 70R; this will be compatible with a low Z feeder. However if a high Z feeder is used then, not only will there be a high standing wave on the feeder, but if it is about a quarter wave (or any odd multiples) long, then the impedance at its input will be resistive at around 1300 R for a 300R feeder and nearly 5000R for a 600R feeder. On the other hand if the resonant doublet is a full wavelength long then its centre impedance will be high and a high Z feeder will be satisfactory - if used with a low Z feeder there will be high standing waves. Again, if the low Z 80R feeder is a quarter wave (or any odd multiples) long and the antenna impedance is 1000 to 1500R, then the matching unit will have to work into just 5R resistive. In practice the feeder is most unlikely to be an exact number of odd quarter waves long and consequently the matching unit will have to work with a wide range of resistive and reactive components.

It would be interesting to know what range of impedances can be matched with your design to the transmitter's desired 50R. By connecting resistances across the feeder terminals, the highest and lowest values for pure resistance could easily be found. Similarly an idea could be obtained for various combinations of resistance and reactances by using resistors in parallel with capacitors or inductors across the terminals. Although obviously intended for QRP use it would interesting to know what its upper power limit might be and the associated power losses for the T200/2 transformer core.'

Craig, you have to tell us about the feeder, what you built and how you got on with the suggestions. Also do try reducing the number of link winding turns!

As a further comment, I have been trying to devise a good AMU kit for quite a while which could handle a wide range of frequencies and impedances. It really does need variable inductors and air variable capacitors but new prices are high! The simplest two control scheme is that below. G3PCJ



Upstairs earthing?

Looking in my file of snippets for Hot Iron I find a follow up note from Craig G0HDJ on earthing matters. "My main supply is electrically isolated from mains and RF earth as I often use gel cells at home as well as when operating portable. My base station is on the second floor so how should I 'earth' the station? I could run a stout but long cable (or shorted coax) to a rod driven into the dry earth outside, with rock not far below, or would a quarter wave counterpoise across the floor be better, or should I bond it all to the central heating?"

Given the earlier questions about a doublet antenna I don't think you should need to worry about RF earthing and so I think safety matters are the main concern. The reason behind this is that the doublet antenna is symmetrical with two arms of equal length irrespective of whether it is a half or full wave or some other length. Provided you feed it with a balanced form of feeder (i.e. not coax) from an AMU with a balanced output, (i.e. neither output terminal having a low impedance path to any sort of RF earth), there should be nothing to upset this desirable state of balance. Within the AMU there should be some sort of RF transformer such as that in the circuit at the bottom of the previous page. It is desirable that the matching circuits should be symmetrical as in Eric's circuit higher up the page, however it is not essential provided the stray capacity of all parts to any form of RF earth is low - to avoid the unwanted low impedance path to RF earth. With such a balanced antenna, feeder and AMU output there should not be problems with 'RF in the shack'; if there is, the best way to get a good upstairs RF earth is with a quarter wave counterpoise cut for the band in use and connected to the rig's chassis or ground plane - NOT to either AMU 'hot' output terminal. If the AMU circuits are symmetrical and do have a suitable balance point for connection to RF earth this is really the best place for a counterpoise. Connection to the real earth via a long wire and dubious rod is not going to be much good at RF and maybe dangerous from a mains safety aspect (see earlier Hot Iron article on mains earthing/PME). Connection of the rig chassis to the mains earth or central heating is not going to give a good RF earth for much the same reasons - the real earth is distant! So if there is RF in the shack use a quarter wave counterpoise connected to the rig chassis or AMU balance point. However this will not cover the safety aspect which is mainly the risk of unexpected (high? static?) voltages building up between rig and mains earth owing to the absence of any path to remove the volts. This is the real reason for connection of the rig chassis to mains earth or the central heating which should be bonded anyway to mains earth. The antenna arms should also have a DC path somewhere to earth to dissipate lightning static - without a low Z balance point which can be earthed as above, use 100K to chassis/mains earth from the point in the AMU circuit where the RF voltages are least. See sketches.

So the general answer is to use a balanced antenna and feed system, connect rig chassis to mains earth or other mains bonded metalwork for safety, provide a static discharge route for the antenna arms and if there is RF in the shack, add a quarter wave counterpoise (or several if more than one band is troublesome) connected to rig chassis. When working portable, use an earth spike instead of mains earth or the central heating!

For unsymmetrical antennas, the RF earthing becomes much more critical! G3PCJ

Snippets

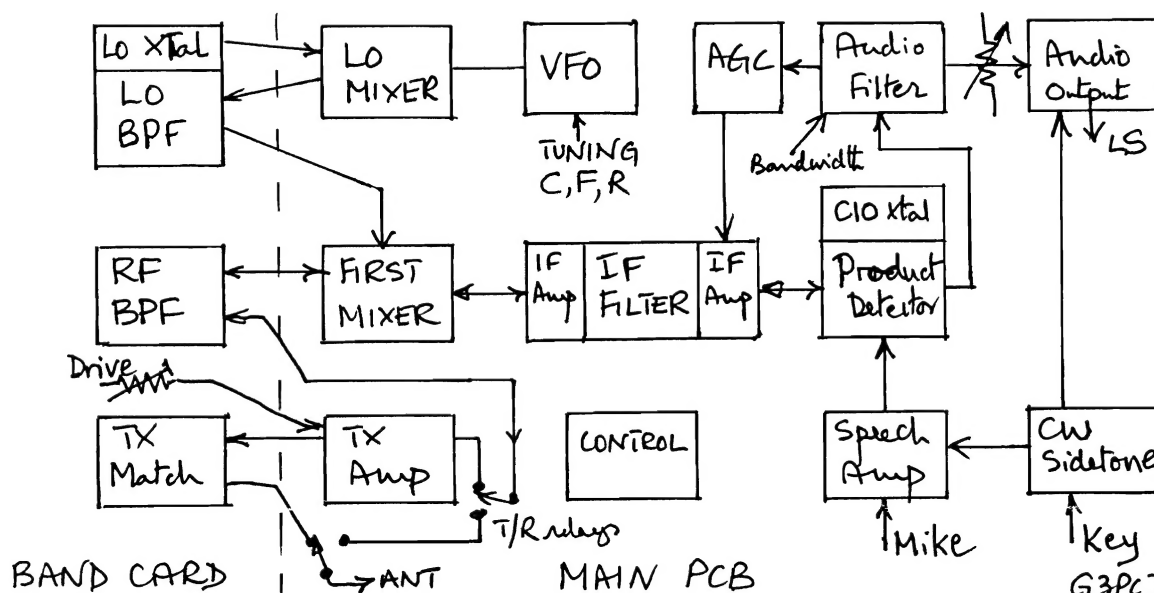
Paul Tuton sings the praises of Ethernet terminators as 50 Ohm dummy loads. They are generally a BNC connector with a built 50 Ohm resistor for properly terminating RG58 coax Thin Ethernet cable used for interconnecting multiple computers. He uses one attached to a PL259 adapter and reports it quite happy to absorb 2 to 3 Watts all day and even with 10 Watts it allows sufficient time to tune up an AMU before it gets too hot. SWR is 1:1 to at least 50 MHz and maybe a lot higher. They cost about £2 in PC World.

Printed Circuit Boards. Sometimes it happens that I produce a slightly damaged PCB because I inadvertently scratched or removed the photo-resist when handling the board prior to etching. Quite often this does not get noticed until after they have been drilled and cleaned. By that time nearly all the cost has been incurred so it is a pity to chuck them away! I keep the PCBs with minor damage in case somebody is quite happy with the odd wire bridge. Currently I have a Bruton TCVR PCB and a 5 digit counter with minor damage. If you are contemplating either projects, ask me about discounts! G3PCJ

Capacitor types. Disc ceramic capacitors are prone to microphony! Medium sized capacitors to about 500 nF in the audio signal path should be polyester. The alternative dielectrics known as X5R and Y5V are often suggested on space/price grounds. X5R changes about 5% with temp but decreases in value by 40% as DC voltage increases to just 16 volts! For Y5V, the figures are -60% for temp and -80% for 10 volts DC. Avoid! The COG dielectric is good - it hardly changes with temp. G3PCJ

The Bristol

It is a multi-band 5 Watt CW and SSB superhet transceiver, capable of operation on all 9 bands from 160 to 10m by plug-in cards. The basic TCVR can take one card, for either a single or pair of bands. If the card switch kit is added, two cards (twin or single) can be fitted allowing front panel selection of up to any four bands. You can change cards for all the others! The rig is a bi-directional superhet with 6 MHz IF and five crystal ladder filter. It has IF amplifiers before and after the filter, the latter being controlled by an audio derived hang AGC system. The audio section has a very high performance adjustable filter with settings for SSB and CW, followed by an output stage for LS or phones. TR control is semi break-in for CW. The low frequency varactor tuned VFO, with coarse & fine tuning plus RIT, has good stability and provides a nominal coverage of 500 KHz on each band card. The VFO output is mixed with a band dependent crystal using a frequency scheme that automatically selects the sideband normally used for phone on each band. The transmitter is basically broadband with a tuned MOSFET output stage. Each band card carries the LO crystal, double tuned LO and RF filters and the transmitter output matching network. This is a simplified block diagram:-



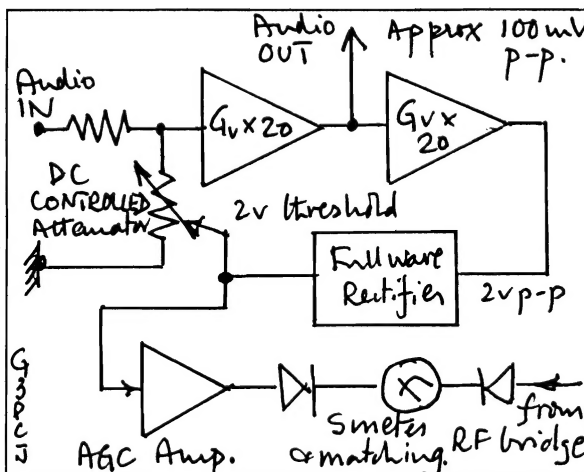
The main PCB is 100 x 160 mm with the band cards (50 x 160 mm) being inserted vertically along the rear edge. The card switch PCB has to be mounted immediately behind the main PCB. Both it and the counter PCB are 160 x 50 mm. In addition a meter kit is available to provide an S meter (with extra audio derived AGC) and a resistive transmitter matching bridge plus output indicator.

The TCVR prices include a Manual and a subscription for one year to the Construction Club.

Single Band TCVR	£129	Manual	£ 5
Two Band TCVR	£149	Extra Single band cards	£16
Four Band TCVR inc. card switch	£199	Extra two band cards	£39
Meter kit	£ 24	Five digit counter ordered with rig	£45

S Meter and audio AGC

Although designed for the Bristol, this meter kit can be used with any rig. The matching bridge section is my standard resistive bridge design. The block diagram of the AGC and S meter part are shown right. It depends on an input variable attenuator controlled by the audio AGC voltage which is also fed to the S meter circuit. Both audio amps have a nominal voltage gain of 20. The attenuator acts when the DC control voltage rises above 2 volts which occurs when it is driven by an audio signal of 2 volts p-p. This implies a stabilised audio output to the rig of 100 mV corresponding to a input of 5 mV p-p. At inputs below this the gain is times 20. G3PCJ

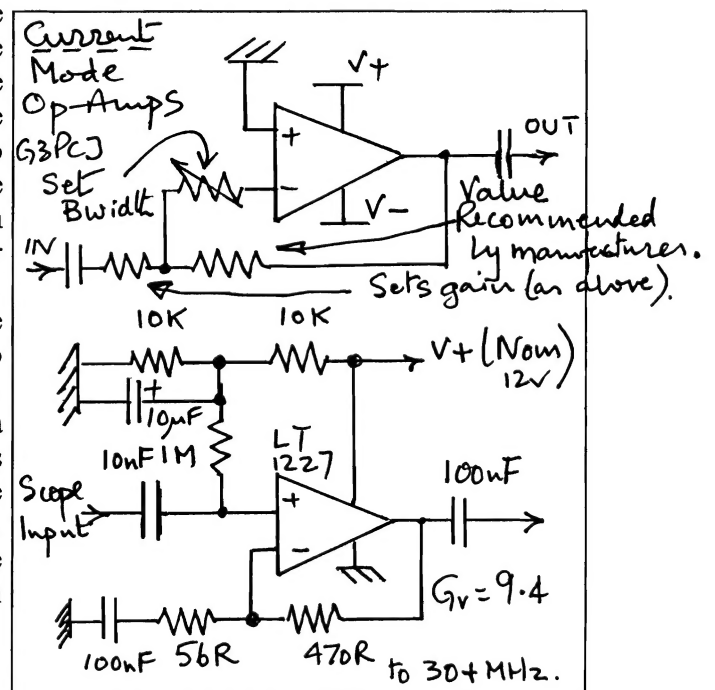
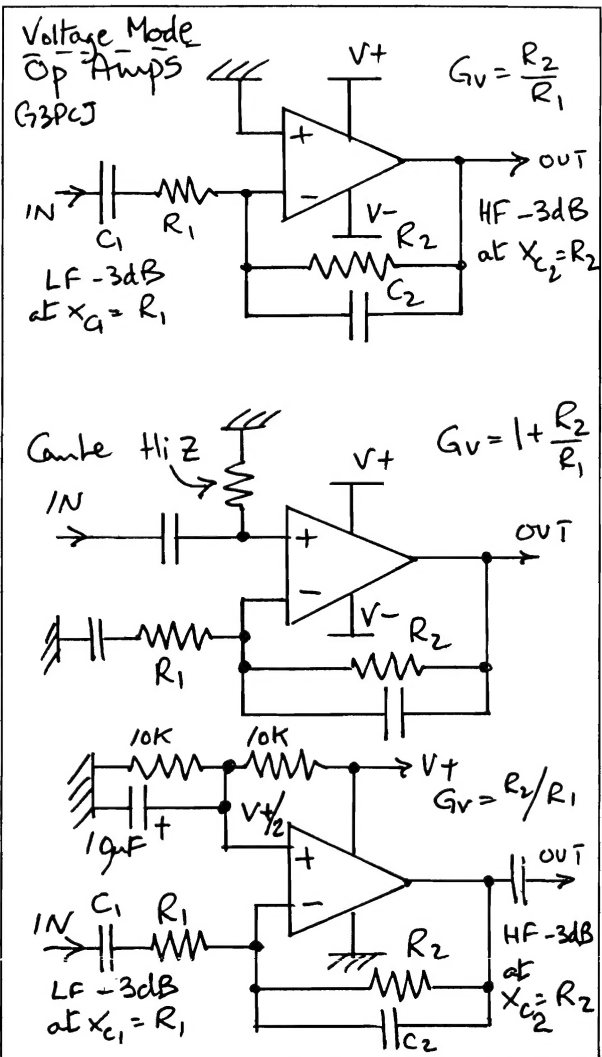


Voltage and Current feedback op-amps

Operational amplifiers can be used in many different configurations but the most common 'voltage' arrangements for audio applications are shown on the right. If symmetrical supplies either side of 0 volts are available, then the positive input is normally biased at 0 volts, either directly as in the top circuit, or when the signal input is also applied to the positive input, by a resistor whose value is high compared to the signal source impedance such as in the second circuit. Biasing in this manner is intended to set the op-amp output voltage to 0 volts for maximum signal swing. Bearing in mind that modern op-amps have very high input impedances, the positive bias input resistor can be large so allowing extra earlier stages of passive signal passband shaping without too much loading on the passive circuit. If only a single supply is available, the positive input and hence output, is biased at mid supply by a decoupled resistive supply halver as in the lower.

The gain of these circuits is principally determined by the two resistors associated with the negative input. These usually form an attenuator from the output - the greater the attenuation, the greater will be the whole circuit gain but of course ultimately limited by the gain and bandwidth of the op-amp itself. The ratio of these resistors is roughly the circuit gain - see actual formulas by the circuits. Generally the capacitor across the feedback resistor sets the high frequency bandwidth while the capacitor in series with the other resistor determines the low frequency bandwidth.

Current mode op-amps are used where the highest possible frequency range is required - often into many MHz of circuit bandwidth. Their internal circuitry is different with circuit performance (bandwidth) much more dependent on the impedance at the negative input. Data sheets often quote the best value of feedback resistor requiring that the other negative input resistor has to be used to set the stage gain. Placing a capacitor (small) across the feedback resistor to control upper bandwidth can be a bit fiddlesome to determine the best value due to strays etc.. Another approach is to put an low value resistor in series with the negative input as shown right. I have never seen a mathematical approach for determining its value but up to 100R are suggested. One note suggests a preset but I would prefer the 'adjust on test' approach for a one off project! Zero series resistance will give the highest bandwidth. Some years back I used the lower circuit right for a wide bandwidth buffer for scope type probes. It has a nominal gain of times ten to compensate for the attenuation by ten in wide bandwidth scope probes. The LT1227 is a readily available current mode op-amp. It had a bandwidth approaching 30 MHz in this circuit. G3PCJ

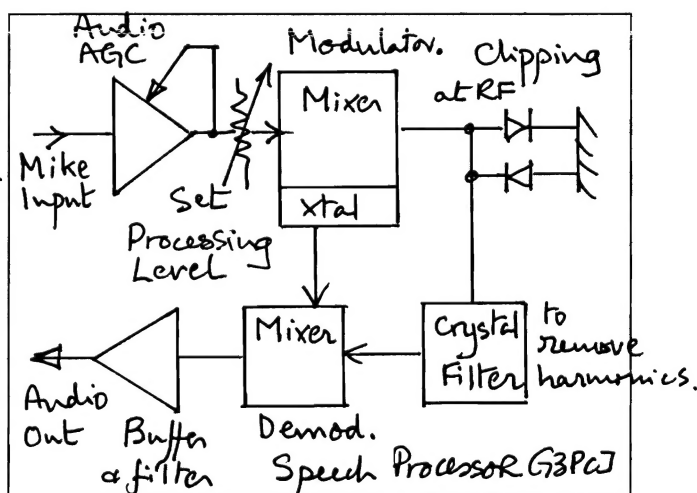


Identifying Capacitors

Alan G0HBC points out that many of us don't see quite as well as we used to and this is a particular problem for small capacitors. When trying to identify them in a kit bag, the first thing is to sort them by type. Electrolytics are easy recognised by their polarity markings. Polyester types (that I use!), in the range 1 to 470 nF, are small rectangular plastic blocks, often blue or grey or yellow, and marked somany 'n'. Ordinary low tolerance general purpose disc ceramics are small discs, often buff or reddish brown, with their value marked in picofarads as two digits followed by a decimal multiplier like resistors. Eg. 103 is 10,000 (pF) which is actually the same as 10 nF - a disc marked 471 would be 470 pF etc.. Be aware that something marked 330 might be actually 330 pF or 33 pF depending on whether its a real number or two digits plus multiplier! Other low value capacitors are either ceramic plate, with a thin rectangular green shape or special temperature compensating types (discs or blobs!). The ceramic plates have very faint small black markings - when new they can be read with a magnifying glass and some guesswork! They are usually marked somany 'p' or with the p separating two digits for very low values e.g. 4p7. These ceramic plates have a black tip if they are NPO, meaning a nominal zero temperature coefficient for values below about 27 pF; alternatively they have an orange tip for slightly larger sized values which implies a N150 temperature coefficient or one which goes down by 150 parts per million per degree centigrade. Other temperature compensating types are also ceramic discs but usually a little bigger, with buff or green bodies, marked as two digits and a decimal multiplier. Both types are N150 - in addition the buff ones have an orange tip N150 indicator. The blue blobs are ceramic COG types, again with a nominal zero tempco; their value is marked as two digits and a decimal multiplier. Having sorted them by type, compare the numbers with the parts list for each size and value. Almost without exception, for the same type, smaller physical size means smaller value. So see if you can find similar ones and compare the numbers in the bag with the numbers of different types in the parts list. Obviously, if you have a capacitance meter, such as now included on digital multi-meters, this will help but do keep the lead lengths as short as possible! This advice is of limited help - later I hope to have a simple capacitance indicator kit! G3PCJ

Speech processing suggestions

Andy Howgate has suggested a general purpose speech processing kit that would go with any brand of rig; I would also add a replacement for the Plessey SL6270 VOGAD chip which is now almost unobtainable (I do have some!). I have in mind to use the type of AGC circuit mentioned earlier for the meter kit - this would ensure that the clipping circuits have a stable input level to make it easier to set up. It would use a couple of 602 mixer chips and crystals to transform up to RF for the clipping and filtering and back down to audio. I guess that it might take up a 50 x 80 mm PCB and cost about £30. The block diagram would be something like that right. Anyone interested?



Somerset Range Rigs

Just a brief reminder of the main kits available:-

Chedzoy	Starter kit, MW plus 80m Regen TRF	£19
Priddy	First serious kit, 20, 40, & 80m DC RX	£39
Godney	3 band crystal CW TX 1.5W	£29
Sparkford	80m Cer Res VFO CW TCVR 1.5W	£34
Porlock	6m from 20m Transverter 3+W	£44
Minehead	CW VFO TCVR, 5W single band 20 to 160m	£49
Bruton	SSB Superhet TCVR, 5W, single band 20 to 160m	£84
Radstock	CW Phasing TCVR 5W, two bands 10 to 160m	£79
Langport	CW & SSB, 20 & 80m 5W superhet TCVR	£128
Taunton	Multi-band SSB TCVR 5W, 1/2 bands, 15 to 160m	£99 up
Counters, 3 and 5 digit, adjustable CW filter, optional extras, QRP Booster, Low pass filters, Two tone oscillators, signal generator and loads of spares for all the older rigs!		G3PCJ